November/December 2002

Zoogoer

Volume 31 / Number 6

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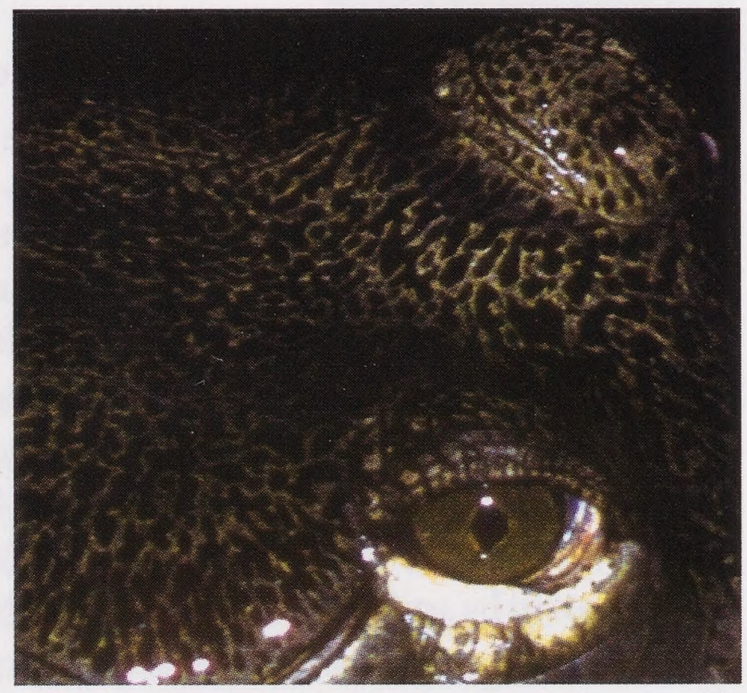

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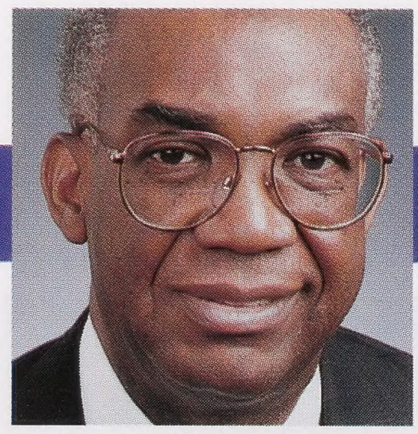

FONZ Forum

It has truly been a delight to see Kandula grow and change in the last year. Kandula, the male Asian elephant born at the National Zoo on November 25, 2001, has grown from 325 to nearly 900 rambunctious pounds, a real handful for his keepers! But in the coming years, Kandula will reach more than 10,000 pounds—five tons!—and that's lots more than a handful. In fact, so strong, feisty, and unpredictable are adult male elephants that few zoos are able safely to contain them. Zoo Director Lucy Spelman's ten-year renovation plan calls for building a new, spacious, male-elephant-proof exhibit for Kandula and the rest of the Zoo's Asian elephants—including any young born in the future.

In fact, Zoo scientists recently reported that Shanthi, Kandula's mother, had her first post-pregnancy estrous cycle in June. This means she could become pregnant again. As you may remember, Kandula was conceived by artificial insemination, a real breakthrough for Asian elephant conservation. Although no firm plans have been made, Zoo staff may try to repeat this success in the next few years. Eventually we hope to have a family herd of about ten elephants that would include several females and their young, the sort of social grouping seen in the wild, as well as two to four adult males.

Design, construction, and completion of the new facility, which will be part of our Asia Trail program, will take several years, however, so we need to make some short-term improvements in our Asian elephant yards to accommodate Kandula's needs, as well as benefit Shanthi, Ambika, and Toni.

Whether watching Kandula in person or on a webcam (http://www.nationalzoo.si.edu/Webcams/elephantcam/), I never fail to be charmed by his playful antics. Just a few days ago, keepers offered him a huge cardboard box, which he seemed to joust in delight. Like human children, Kandula is constantly testing his developing strength and physical abilities, as well as the patience of his mother and his keepers!

To offer Kandula a more stimulating environment and more room to roam, Zoo staff will renovate the outdoor enclosure of the greater one-horned Asian rhinos and open it up for the elephants. The rhinos are going to another facility for breeding, as recommended by the American Zoological Association's Rhino Species Survival Plan. Rhinos will return to the Zoo in the future, however, so the renovation is being designed to meet the needs of both species.

Part of the renovation will include making the new area safe and secure for young Kandula. In addition, staff will be testing various new enrichment features to see which the elephants most prefer. This information will assist designers of the planned new Asian elephant habitat, just as staff are doing with giant pandas Mei Xiang and Tian Tian. One interesting feature that may be installed during the renovation is a shower that an elephant can choose to turn on by pushing against a mechanical "on" switch. Knowing how much elephants enjoy their daily baths, staff are pretty sure they will like the shower, but this test will demonstrate whether their intuitions are correct.

We are looking to you, as Friends of the National Zoo, to help make this plan a reality—and the Zoo a more fun place for Kandula and everyone who watches him. We are hoping to raise $300,000 to complete this plan, a relatively small amount if everyone pitches in.

You should have received by now a letter in the mail asking for your support. Please consider making a contribution to expand Kandula's horizons. You can mail your contribution or donate online using our secure server. As the Zoo Director outlines in her letter on page 5, the generosity of FONZ members allows the Zoo to do many things that would otherwise be impossible given the constraints of the Zoo's federal budget appropriation. Thank you for your continued support of our mission to celebrate, study, and protect wild animals and their habitats.

Sincerely,

Clinton A. Fields
Executive Director

P.S. Don't forget to join us in celebrating Kandula's first birthday on Saturday, November 23, from 10 a.m. to 2 p.m. See page 6 for details.

Friends of the National Zoo is a non-profit organization dedicated to supporting the conservation, education, and research efforts of the Smithsonian's National Zoo. Formed in 1958, FONZ was one of the first conservation organizations in the nation's capital. Friends of the National Zoo is dedicated to supporting the Smithsonian's National Zoo in a joint mission to study, celebrate, and help protect the diversity of animals and their habitats.

ZooGoer [ISSN 0163-416X] is published bimonthly by Friends of the National Zoo (offices located at the Smithsonian's National Zoological Park, 3001 Connecticut Ave., N.W., Washington, DC 20008-2537) to promote its aims and programs, and to provide information about FONZ activities to its members, volunteers, and others interested in the purposes of FONZ. Periodicals postage paid at Washington, D.C. Postmaster: Send change of address to *ZooGoer*, 3001 Connecticut Ave. NW, Washington, DC 20008-2537. Copyright 2002. All rights reserved.

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Membership in FONZ offers many benefits: publications, discounts on shopping, programs, and events, free parking, and invitations to special programs and activities to make zoogoing more enjoyable and educational. To join, write FONZ Membership, National Zoological Park, Washington, DC 20008, call 202.673.4961 or go to www.fonz.org.

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ZooGoer
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Cover photo: A juvenile peregrine from a cliff eyrie in New Hampshire in 2001. Photo by Chris Martin / Audubon Society of New Hampshire.

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STATEMENT OF OWNERSHIP
ZooGoer [ISSN 0163-416X]
Friends of the National Zoo
3001 Connecticut Ave., N.W.
Washington, D.C. 20008-2557
Publisher: Clinton A. Fields
Editor: Susan Lumpkin **Associate Editor:** Brendan Horton
$8 of membership dues goes to subscription

	Avg. No. Copies Preceding Year	No. of Copies Sept/Oct issue
Net Press Run:	36,091	38,000
Paid Outside-County Subscrip:	29,150	30,894
Paid In-County Subscrip:	4,317	4,663
Sales through Carriers, Counter Sales:	55	8
Total Paid/Requested Circulation:	33,522	35,565
Free Distribution by Mail:	806	865
Free Distribution Outside Mail:	233	125
Total Free Distribution:	1,039	990
Total Distribution:	36,091	38,000
Copies Not Distributed:	1,530	1,445
Percent Paid/Requested Circulation:	97%	97%

Letter from The Zoo Director

Dear ZooGoer:

In September 2001, I asked the Smithsonian's National Zoo staff to tell me what they needed to help make the Zoo a better place for our animals, for our visitors, and for our employees as we work to restore our reputation as one of the world's great zoos. The result was what I call "The Top 110 Things You Want Done List." My challenge was to take action or find funding for as many of these 110 things as possible by applying our federal and nonfederal support as efficiently as possible.

The first step was to assign priorities to each of the items. This is not an easy task when your organization consists of a collection of living creatures: essentially, everything deserves funding. However, with input from people throughout the Zoo, we were able to prioritize the list. As funding sources were identified, they were applied to the list according to priority. This process ensures that our budget process is objective; decisions to fund an item on the list are based upon a plan rather than an individual request. To use a veterinary analogy, triage is necessary, and it works. What's more, even with all the funding in the world, we are limited by the number of people we have to accomplish the work each year.

So, how did we do and how did we do it?

How did we do? We made excellent progress. Overall, 90 percent of the items on the list, or 95 of 105 (five were cancelled at the request of the staff) are complete or well on their way to completion. For example, in the last year we have purchased veterinary imaging equipment, hired educators, ecologists, and electricians, built a new octopus tank and Komodo dragon yard, installed webcams, and planned renovations like Sloth Bears and Asia Trail. Animals, visitors, and staff all benefited.

How did we do it? Twelve items on the Top 110 List required action only. Of the rest, about two-thirds received federal support, and one-third nonfederal support. That one-third was about $4 million, including $2 million raised by Friends of the National Zoo for Asia Trail. Of the remaining $2 million, FONZ allocated $1.2 million and the CRC Foundation allocated $0.8 million. In addition, FONZ supported several other projects, provided grants for research, and allocated funds to the giant panda program to bring FONZ's total contribution to $5 million in 2002. Overall, non-federal support to the Zoo for projects and research in 2002 was about four times that of 2001.

In the future, we will continue to prioritize our work and allocate federal and nonfederal funds based upon a menu of actions or projects. I believe this process is essential in light of the Zoo's recent budget history. Each year, the Zoo receives a federal allocation to cover salaries (including benefits), operations, and capital renewal (repair and renovation). Most staff members are federal employees, so our federal allocation goes to salaries and benefits first, and operations second. Because of trends beyond our control—our annual federal allocation does not increase at the same rate as mandated annual federal pay raises—we are gradually spending a greater proportion of our federal funding to pay our staff. The amount leftover for operations—just ten percent of the total—is not enough to pay for "nuts-and-bolts" operations and all of our programs.

Fortunately, we have tremendous—and growing—nonfederal support from FONZ and the CRC Foundation. In addition, we hired more than 60 new employees last year, bringing new energy and expertise to the organization. Together, we have a strong National Zoo team, of which I am very proud. We accomplished a lot over the past year, despite a difficult time, particularly in terms of our local and national economy. We could not have done it without teamwork.

I am also truly grateful for the support of FONZ members and members of the CRC Foundation. As the numbers I've reviewed here attest, we couldn't do it without you.

Thank you.

Lucy H. Spelman
Director
Smithsonian's National Zoological Park

Notes & News

>>ANIMAL NEWS

A black-footed ferret (*Musela nigripes*) born earlier this year was more than just a cute ball of fur. For those of you keeping score at home, this marked Jo Gayle Howard's 100th black-footed ferret born at the Smithsonian National Zoo's Conservation and Research Center by an artificial insemination procedure that Howard developed and first implemented in 1996. The procedure is one of the reasons that this native of the North American West is recovering from its close brush with extinction. For a time in the 1970s, biologists believed the species was extinct,

JESSIE COHEN / NZP

but a small population was discovered in Wyoming in 1981. Things turned dark again in 1985 when sylvatic plague reduced the number of prairie dogs, upon which the ferrets depend entirely for food. To compound the problem, an outbreak of canine distemper hit the ferrets that same year.

Between 1985 and 1987, biologists stepped in, capturing the last 18 black-footed ferrets and initiating a captive-breeding program in Wyoming. National Zoo scientists were advisors on the program from its inception and, in 1988, the Zoo became the first center outside of Wyoming to hold and breed the animals. Since then, more than 250 ferrets have been born at CRC, where the Zoo's project is based. All told, more than 4,000 black-footed ferrets have been born in captivity since 1985.

Later, it emerged that more than half of the males were failing to father young through natural breeding. Without Howard's artificial-insemination technique, the program might have lost the genetic input of some 50 percent of males and the genetic diversity of the captive population would have been compromised. Today, breeding centers all over the country send their problematic, and genetically valuable, males to Howard. For more information about the recovery and release of black-footed ferrets in Wyoming, South Dakota, Montana, Arizona, Utah, Colorado, and Mexico go to www.fonz.org.

On September 17, the Zoo opened a new open-air, outdoor enclosure for its adult Komodo dragon siblings, Kraken and Precious. The new enclosure was made possible by generous donations from four FONZ members. For the world's largest lizard, basking in the sun is one way to maintain its health and regulate body temperature. The dragons' 620-square-foot addition will allow them to roam outdoors and benefit from direct sunlight in warm-weather months. The seven-foot female known as Kraken and the male, Precious, are kept in separate enclosures and are let outside on a rotating schedule. The dragons are free to return to the indoor exhibit where there is ample shade and water, and where their underground burrows are located.

JESSIE COHEN / NZP

Komodo dragons (*Varanus komodoensis*) grow as long as ten feet and can weigh more than 350 pounds. Native to the remote Indonesian islands of Flores, Komodo, and Rinca, they inhabit tropical forests, grasslands, and seasonally dry riverbeds. Young dragons live mainly in trees and prey on small lizards but, as they grow, their prey will include deer, goat, and wild boar. A large adult can bring down a 1,300-pound water buffalo, and if unsuccessful in direct attack, a bacteria-laden bite will often do in prey over time. The dragons are endangered; nonetheless, the population in Indonesia remains stable and the lizards have become a lucrative tourist attraction. The National Zoo—the first zoo outside Indonesia to hatch Komodo dragon eggs—has reared 55 dragons, which have been sent to about 30 zoos worldwide. Kraken and Precious are from the Zoo's first clutch of 17 eggs hatched in 1992.

>>FIESTAS

Fiesta Musical 2002 was a resounding success! FONZ and the National Zoo hosted about 20,000 visitors to the Zoo on Sunday, September 22. The annual celebration of Latin American culture is held every September as part of the Smithsonian Institution's Hispanic Heritage Month. Wonderful live music and dance performances, traditional Hispanic cuisine, and a bevy of exciting activities for kids of all ages highlighted the 2002 installment. More than just a celebration, the event afforded guests the unique opportunity to talk to Zoo scientists about research they are conducting all over the world. Bilingual animal demonstrations and the Find Out Why? game for kids also added to the educational value, which is an important component of Fiesta Musical.

Another party will be put on by FONZ and the National Zoo on Saturday, November 23. This one is to celebrate the first birthday of Kandula, the Zoo's ever-popular elephant youngster. The free event will take place from 10 a.m. to 2 p.m. at the Zoo's Elephant House. Guests will be treated to a variety of animal demonstrations, interactive activities, and an arts-and-crafts area for kids. They'll also watch Kandula eat a special birthday treat. For more information, check out the FONZ website at www.fonz.org.

September was Be a FONZ Month, celebrating senior citizens. For the entire month of September, seniors were invited to visit the Zoo, with free parking and discounts in the National Zoo Stores. On Tuesdays, a cool tented area with free beverages and special up-close animal demonstrations were provided. Over 60 new seniors joined Friends of the National Zoo in September and received the *Smithsonian Book of Giant Pandas* and a panda tote bag.

JESSIE COHEN / NZP

>>VOLUNTEER CORNER

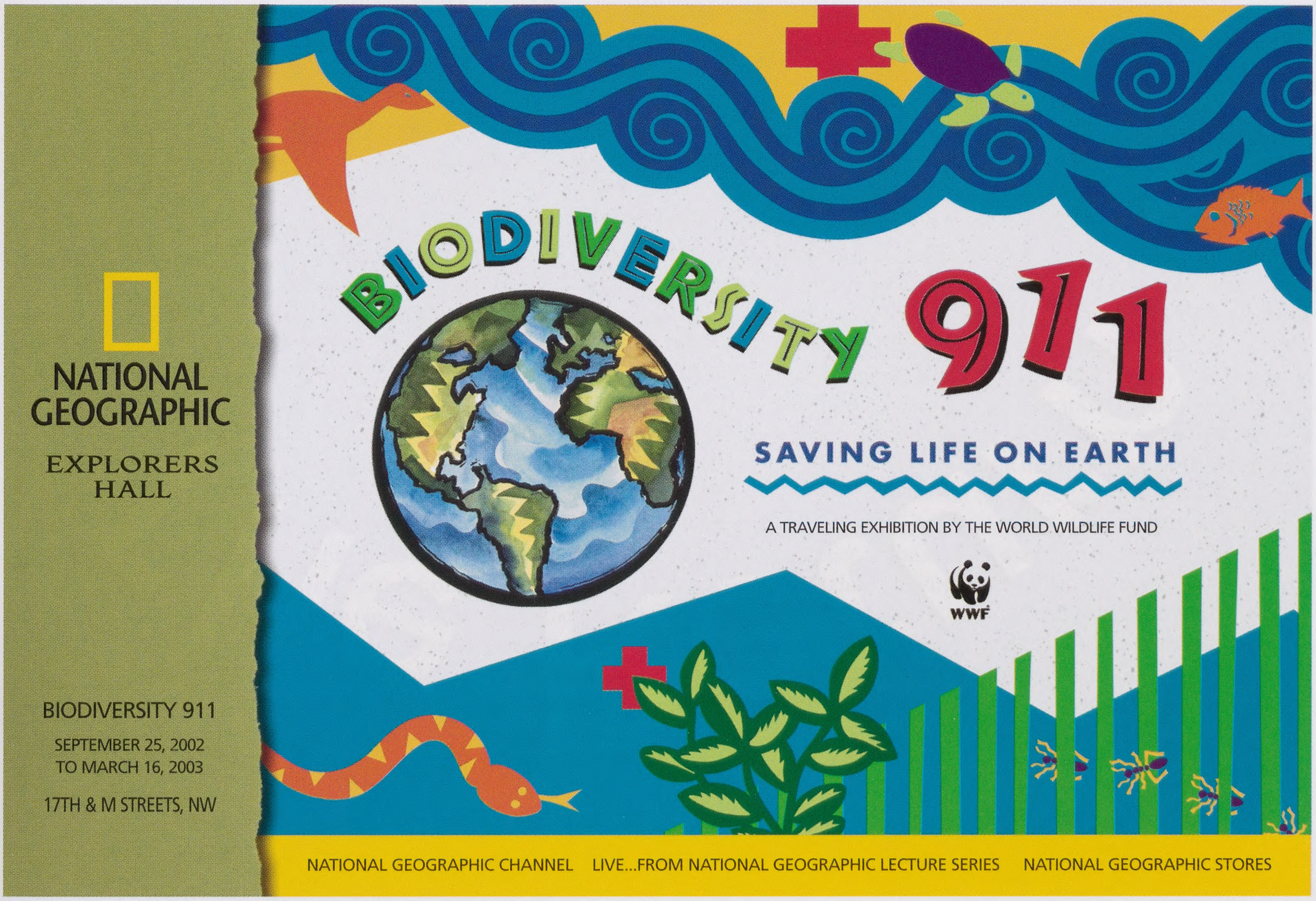
Friends of the National Zoo offers a variety of summer opportunities through the Teen Volunteer Program, a program for teenagers between 13 and 17 years old. During this past summer, more than 100 enthusiastic teenagers volunteered their time at the Smithsonian's National Zoo. One of our most popular volunteer initiatives is the Class Aide Program, which is for teens 13 and older. Class Aides assist FONZ teachers during the Summer Safari Day Camp, helping to expose children to a wide variety of animal-related and environmental topics, which are geared toward children in kindergarten through fifth grade. Teens in this program assist with classroom set-up and cleanup, interact with children during class activities, and help supervise Zoo walks.

The Teen Volunteer Program also has opportunities in the How Do You Zoo? exhibit, which is staffed by teenagers 14 and older. This hands-on exhibit teaches children about the many career possibilities at the Zoo. It has four sections that depict an animal keeper's office, veterinary hospital, commissary, and animal exhibit, and children learn about jobs in these areas through role-playing in a make-believe zoo. During the summer, teen volunteers oversee the exhibit, interact with young visitors, and help conduct programs for D.C. Department of Recreation groups.

Another interesting volunteer opportunity for teenagers is the Exhibit Greeter Program for teens 16 and older. Volunteers in the Exhibit Greeter Program welcome visitors at Zoo exhibits where a limited number of people are admitted at one time, such as the Invertebrate Exhibit and the Reptile Discovery Center. Using educational tools and information acquired during training with the Zoo's keepers, teens serve as ambassadors by answering questions, explaining the purpose of controlled access, and maintaining a record of the number of visitors entering the exhibits.

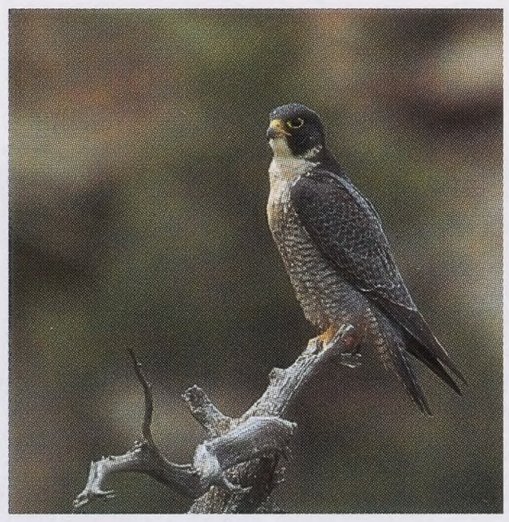
Teens interested in working outdoors in the Zoo's many gardens and landscaped areas may enjoy the Horticulture Program. The National Zoo places special emphasis on the interconnectedness of all living things and, as such, its grounds and gardens are not only decorative, but educational. Teen volunteers 16 and older work with the Zoo's gardeners to help maintain these important areas.

As volunteers in the FONZ Teen Volunteer Program, teens not only have the opportunity to earn community service hours, explore future careers, and learn more about the Zoo and its residents, they can also take pride in the fact that they are providing invaluable services and support to the Zoo. So if you are a teen, or have a teen looking for an exciting way to spend part of the summer, the FONZ Teen Volunteer Program may be the program for you. For more information or an application for next summer's volunteer programs, please log onto the FONZ website at www.fonz.org or call 202.673.1688.



BRIAN K. WHEELER

The Return of the Wanderer



BRIAN K. WHEELER

A WESTERN *ANATUM* MALE SCANS THE COLORADO COUNTRYSIDE FROM ITS TREE-LIMB PERCH.

BY MATT OLEAR

"Capable of flying at tremendous speeds and executing astonishingly agile maneuvers, the peregrine falcon is a true ruler of the air, fully worthy of its fame as a raptor of unequaled predatory abilities."

—*Noel and Helen Snyder,* Raptors: North American Birds of Prey

The piercing cries drifted up the valley, penetrating the dense fog as we headed down the side of the mountain ridge. Winding our way furtively through rain-soaked trees, we paused to watch and listen. Perched on the lip of a cliff ahead of us were two wooden boxes, shrouded in the morning mist. Contained in one of those boxes were the reasons for our excursion into the mountains overlooking Harpers Ferry, West Virginia, that mid-June morning.

Three female peregrine falcons (*Falco peregrinus*) were about to be granted their freedom.

Three male peregrines had been released ten days earlier, and the cries of the females at our approach had them buzzing excitedly about the hazy treetops. Trying to keep an eye on the birds' silhouettes, I peered over the cliff but was unable to see the Potomac River meandering far below. Although the weather and foggy conditions delayed the females' release several days, it was decided that they would be fitted with the solar-powered satellite transmitters that scientists hoped would track their wanderings for the first years of their new lives. One by one, the falcons were carried from the box to a level area on the ridge, each a raucous bundle of feathers and talons. Throaty, high-pitched screams bespoke of the falcons' indignation and ruffled pride. Up close, their most striking feature was the large, dark eyes shining out from their chocolate brown heads and boring into me. After being hooded to keep them calm, a transmitter, about two inches in length and weighing about an ounce, was strapped to each falcon's back with waterproof neoprene and polyester straps. They are designed to stay on for life, but will probably be taken off once the birds select breeding territories.

This release is part of a project that began in 1996 when Shawn Padgett, a research associate for the College of William & Mary's Center for Conservation Biology (CCB), discovered that many falcons that hatched in nests on bridges were not fledging successfully. It turns out that falcons in these nests often drown while learning to fly. Bridge nests, located directly over water, offer young falcons few places on which to perch during their critical first flights. Padgett estimates that in Virginia at least 80 percent of peregrines born on bridges die as a result of drowning.

In addressing the issue, Padgett devised a plan to take a selection of falcons hatched in bridge nests and release them in areas of the Appalachian Mountains where the species originally nested. Not only would this solve the problem of high mortality in these nests and give the young birds a better chance to survive, but it would also allow the CCB to resurrect its falcon reintroduction program, which had ended prematurely in 1993 as a result of lagging funds. Moreover, the CCB could now use a wild peregrine population for reintroduction rather than captive-bred falcons, significantly reducing the cost of the project. Padgett first consulted with Mitchell Byrd, Director Emeritus of the CCB, and then took his idea to the Virginia Department of Game and Inland Fisheries. Despite initial skepticism regarding the exceedingly high mortality rate of the bridge-born birds, the program was approved. The first release occurred in 2000, when eight falcons were reintroduced in Virginia's Shenandoah National Park.

In 2001, the CCB tracked 11 falcons from Harpers Ferry National Historical Park and Shenandoah National Park, as well as six hatched on specially constructed towers along Virginia's coast. A glitch in the transmitters' programming caused them to shut off in November, but by that time the falcons had begun to move south. True to their name, which comes from the Latin word *peregrinus*, meaning "pilgrim" or "wanderer," some of the released birds had already traveled great distances, with one from the coast tracked to the Caribbean islands and one from Harpers Ferry last seen near Miami, Florida. Only one bird from this group is still being

AN ADULT MALE PEREGRINE OF THE WESTERN *ANATUM* SUBSPECIES CRUISES THE COLORADO SKY.

tracked, and she currently resides near a power plant just east of Baltimore City.

This year, there have been 12 falcons reintroduced in the mountains and a total of 18 are being tracked: nine hatched on coastal towers, five from Shenandoah, three from Harpers Ferry, and the one still being tracked from last year's effort. As in previous years, those released in the mountains are offspring of pairs nesting on bridges and coastal towers in Maryland and Virginia. So far, 12 of the 18 have been lost, of which four have been recovered. One had a broken wing and will be re-released in Shenandoah after rehabilitation. Padgett believes the others, which include two of the three falcons tracked from Harpers Ferry, are dead. This is a slightly higher mortality rate than for wild first-year raptors that have reached independence.

Those that are still being tracked have dispersed in much the same way as last year's birds, some having already traveled as far as Long Island, New York; the Ohio–West Virginia border; and the Savannah River, 45 miles northwest of Savannah, Georgia. (The falcon currently residing on Long Island was released in Shenandoah and had originally traveled from Pennsylvania to Vermont, a trip of more than 330 miles, in just two days.) Scientists hope that once these birds reach sexual maturity at two to three years of age they will return to their release areas to nest.

Despite the reduced cost of using wild falcons, the project is far from cheap. The primary expense of the current initiative is the satellite transmitters, which cost about $2,500 per bird per year. That adds up to about $45,000 this year alone, not including the cost of feeding the falcons their diet of farm-raised quail. The project is being funded by a variety of agencies and organizations, including the two national parks, the Virginia Department of Game and Inland Fisheries, the Dominion power company, the U.S. Fish & Wildlife Service, and NASA. As fascinating as it is, this project is only the latest chapter in an epic tale of conservation and wildlife management—a decades-long struggle to save the American peregrine falcon from extinction.

THE PEREGRINE

The Potomac River cuts a swath through the Appalachian Mountains, forming the border between Maryland and its neighboring states to the south and west on its way toward the Chesapeake Bay. Where Maryland, Virginia, and West Virginia meet, it encounters the Shenandoah River, creating a scenic vista that Thomas Jefferson declared was "worth a voyage across the Atlantic." There, the Potomac has carved a series of sheer granite cliffs wooded with chestnut oak, maple, and pine. Rising 900 feet above the river's eastern bank is Maryland Heights, a towering wall of rock and woodland overlooking the town of Harpers Ferry. The first written record of peregrine falcons breeding in Maryland was on Maryland Heights in 1883. At that time, the Potomac was dotted with peregrine falcon nests or "eyries," as were other eastern North American rivers like the Connecticut, Hudson, and Susquehanna. In 1952, it was the last known nesting site in Maryland, as peregrines quietly vanished from the state and eventually the entire eastern United States. Fifty years later, I stood on the cliffs of Maryland Heights and observed one step in the effort to return the peregrine to its original breeding range.

The peregrine falcon can be found breeding on every continent except Antarctica. It is a bird of wide-open spaces, nesting predominantly on cliffs overlooking rivers and lakes, on coastal palisades, and in mountains. It builds no nest, but lays its eggs in a shallow depression or "scrape" on a rock ledge. The peregrine is a medium-sized raptor measuring 15 to 21 inches in length with a wingspan of 40 to 45 inches, and weighing anywhere from about one to two and a half pounds. The peregrine's most distinctive feature is the dark plumage that covers its head and extends down through its eyes to its throat, giving the falcon a hooded appearance. As with most raptors, the male peregrine is smaller than the female, in this case by about one-third.

BRIAN K. WHEELER

A JUVENILE PEALE'S PEREGRINE SITS ON A BEACH ON THE PACIFIC COAST WITH ITS PREY, A SHOREBIRD KNOWN AS A MURRE.

...SOME OF THE RELEASED BIRDS HAD ALREADY TRAVELED GREAT DISTANCES, WITH ONE FROM THE COAST TRACKED TO THE CARIBBEAN ISLANDS AND ONE FROM HARPERS FERRY LAST SEEN NEAR MIAMI, FLORIDA.

The peregrine has been called "the world's most perfect flying machine," and like other falcons, it is built for speed and maneuverability. A perfectly designed aerial predator, the peregrine is streamlined and aerodynamic, with long, pointed wings and a short, tapered tail. The peregrine preys on an extraordinarily wide range of birds, from small passerines to waterfowl and game birds, such as ducks, pheasants, and even geese. As a result of its fondness for waterfowl, the peregrine was once known in America as the duck hawk. A peregrine captures birds in flight using a wide variety of techniques. The most famous of this repertoire is the stoop.

At heights ranging from several hundred feet to well over a thousand, the peregrine surveys airspace below with vision eight times more acute than that of humans. When suitable quarry passes

This juvenile peregrine, wearing a satellite transmitter, was released in Shenandoah National Park in 2002. Note the notch or "tooth" in the upper mandible used to dispatch prey.

BRYAN D. WATTS / CENTER FOR CONSERVATION BIOLOGY

underneath, the falcon tucks its wings close to its body and plummets headlong toward its prey at speeds exceeding 200 miles per hour. The momentum of the stoop adds force to the falcon's strike, allowing it to capture prey much larger than itself. If the quarry is not killed outright, the peregrine will sever the spinal cord at the base of its victim's skull using a notch or "tooth" on its upper mandible, a feature common to all true falcons.

DUCK HAWKS OF THE APPALACHIANS

Currently, there are 19 recognized subspecies or races of peregrine falcons in the world, varying mostly in size and coloration. North America boasts three subspecies: the American peregrine (*Falco peregrinus anatum*), which once bred throughout the continental United States and into Alaska, Canada, and Mexico; the tundra or Arctic peregrine (*F. p. tundrius*) of Alaska, northern Canada, and Greenland; and the Peale's peregrine (*F. p. pealei*), inhabiting the northwestern Pacific coast and the Aleutian and Queen Charlotte islands.

The *anatum* subspecies of the peregrine once nested in mountain valleys and gorges and on cliffs overlooking inland rivers and lakes in North America. Separated geographically by a lack of suitable nesting habitat in the flat grasslands of the Midwest, the eastern and western populations of *anatum* differed somewhat morphologically, with eastern falcons being significantly larger than those in the west. The eastern falcons of the Appalachians constituted a distinct subpopulation or "ecotype" of the American peregrine as a result of evolution in relative genetic isolation.

The Appalachian peregrines were adapted to life in the northern-boreal and temperate-forest habitat of eastern North America. They were large, dark falcons—nearly completely black on the head and a buff, rufous color underneath, with spotting on the breast and heavy barring below. These falcons were relatively nonmigratory, remaining on their breeding grounds year-round or migrating short distances to the Atlantic coast. Some even took up winter residence in cities like New York and Philadelphia, taking advantage of the feral pigeon (*Columba livia*) population. With a longer mean wing length than the western *anatum* and larger feet typical of forest-dwelling peregrines, the Appalachian falcons were some of the largest peregrines on record. As a result of captive breeding and reintroduction, the peregrines that now reside in the East are a genetic mix of falcons from the Canadian and Arctic tundra, western North America, the Pacific Northwest, Spain and the Mediterranean, South America, and Scotland.

A young falcon sports the brown and cream plumage of a juvenile peregrine.

CHRIS MARTIN / AUDUBON SOCIETY OF NEW HAMPSHIRE

POPULATION CRASH

The Appalachian mountain chain was once a stronghold for the peregrine in North America. In 1942, University of Wisconsin biology professor Joseph Hickey inventoried 275 nesting sites of the peregrine east of the Rocky Mountains known to egg collectors, falconers, and ornithologists. He estimated there were as many as 350 pairs of peregrines in the Appalachians from Maine to Georgia and Alabama, a figure some biologists now deem conservative.

In the years following World War II, however, local ornithologists and peregrine enthusiasts documented reproductive failure in many historic peregrine eyries in the East. Eyries monitored in Massachusetts, Pennsylvania, and along the Hudson River in New York began to experience difficulty not just in successfully fledging young, but in simply hatching eggs. Then in 1962, more than 20 years after his initial survey, Hickey heard a rumor circulating at the 23rd International Ornithological Congress at Cornell University that not a single peregrine had fledged that year in the northeastern United States. In 1963, after reading a paper by renowned British ornithologist Derek Ratcliffe documenting similar nesting failure in Great Britain, Hickey conducted a review of the same nesting locations he inventoried in the early 1940s. More than 140 eyries were surveyed; none were occupied and not a single adult peregrine could be found. The Appalachian peregrine of the eastern United States had been extirpated. In the West, 80 to 90 percent of peregrine pairs had vanished, and similar

JOE KOSACK / PENNSYLVANIA GAME COMMISSION

ADULT PEREGRINE NESTING ON THE RACHEL CARSON BUILDING IN DOWNTOWN HARRISBURG, PENNSYLVANIA.

declines, though not as dramatic, had occurred in the United Kingdom and across Europe.

In his 1963 article, Ratcliffe hypothesized that the falcons' disappearance was due to the widespread agricultural use of organochlorine pesticides that began after the war. Further research conducted by Ratcliffe and scientists at the Patuxent Wildlife Research Center in Laurel, Maryland, proved that theory to be correct. The pesticide DDT, and its byproduct DDE, was found to be the main culprit. Stored in fatty tissue, DDT worked its way up the food chain from insects to small birds to falcons and other raptors, becoming more concentrated at each level. In peregrines, DDE caused reproductive failure by mimicking natural hormones and inhibiting the female's ability to produce the excess calcium needed to form eggs. The resulting thin-shelled eggs broke under the weight of the incubating falcon. Such a precipitous decline in a relatively short period of time did not bode well for the peregrine or its future recovery.

SAVING THE PEREGRINE

In 1970, the American and Arctic subspecies of the peregrine falcon were listed as endangered under the Endangered Species Conservation Act. Also in that year, scientists at the Laboratory of Ornithology at Cornell University in Ithaca, New York, established a program to restore the country's peregrine population by breeding falcons in captivity and releasing them into the wild. The program, headed by Cornell ornithologist and falconer Tom Cade, would eventually become known as The Peregrine Fund. Few people thought the project would be a success, as up until that point no one had been able to consistently breed raptors in captivity. In addition, the reintroduction program was controversial because it used peregrines from different geographic locations, as the *anatum* subpopulation indigenous to the East had been eradicated. It was decided, however, that by using peregrines from a variety of subspecies sharing similar characteristics with the original Appalachian falcons, nature would select the individuals best suited to the eastern environment.

Despite the challenges, The Peregrine Fund's breeding program was a success, producing its first 20 young falcons in 1973. The following year, the first attempt to reintroduce captive-bred peregrines to the wild took place on the New Paltz campus of the State University of New York—within sight of the Shawangunk ridge of the Catskill Mountains, the location of several historic peregrine eyries. By 1975, The Peregrine Fund was able to breed falcons on a consistent basis, and a reintroduction effort began in earnest. The Peregrine Fund and the U.S. Fish & Wildlife Service, in cooperation with many state and local agencies in the East, created The Eastern Peregrine Recovery Plan. Originally, 11 regions were designated for peregrine releases, but they were eventually condensed into five: Mid-Atlantic Coast, Northern New York and New England, Southern Appalachians, Great Lakes, and Southern New England and Central Appalachians.

Initial releases occurred at or near historic eyries in the mountains and on cliffs along lowland rivers. It was quickly discovered, though, that at many lower elevation sites the young falcons, lacking the protection of adult birds, were vulnerable to predators, particularly the great horned owl (*Bubo virginianus*). To counter this, The Peregrine Fund limited cliff reintroductions to higher elevations in the Northeast and began concentrating releases from specially constructed towers on the salt marshes of the Atlantic coast and in urban areas, where great horned owls are less of a threat. Scientists found that not only was the rate of return higher at these sites, but that the falcons' hunting skills developed more quickly as a result of an abundance of prey.

Although this technique was controversial because falcons had not traditionally nested

MIKE PELCHAT / COURTESY OF THE AUDUBON SOCIETY OF NH

FEMALE PEREGRINE GAZES CURIOUSLY TOWARD THE CAMERA FROM A BRANCH NEAR HER EYRIE IN THE WHITE MOUNTAINS OF NEW HAMPSHIRE.

THE PEREGRINE HAS BEEN CALLED "THE WORLD'S MOST PERFECT FLYING MACHINE," AND LIKE OTHER FALCONS, IT IS BUILT FOR SPEED AND MANEUVERABILITY.

along the Atlantic coast, it proved to be very successful. The Mid-Atlantic region was the first to meet the recovery quota of 20 to 25 pairs, and the first breeding of the peregrine in the East after DDT occurred at a coastal tower in New Jersey in 1980. That same year, the first active eyrie in the eastern mountains was discovered in Maine, and in 1981 peregrines returned to breed at an historic cliff eyrie at Franconia Notch in New Hampshire. All told, more than 6,000 captive-bred peregrines were released in 34 states between 1974 and 1997—the result of collaborative efforts between federal, state, and local agencies; non-profit organizations; and private citizens. It is easily the most extensive and successful recovery effort ever undertaken on behalf of a single species. Finally, in August of 1999, the American peregrine falcon was officially removed from the Endangered Species List. Currently, there are about 2,500 pairs of peregrines throughout the United States and Alaska, with about 300 east of the Mississippi River, most of which nest on coastal towers or in urban areas on bridges and skyscrapers.

U.S. Fish & Wildlife Service biologist Craig Koppie bands falcon chicks in Virginia's Shenandoah National Park in 1994.

CRAIG KOPPIE / U.S. FISH & WILDLIFE SERVICE

RESTORING FALCONS TO THE APPALACHIANS

When scientists began concentrating peregrine releases in urban areas and along the Atlantic coast, it was hoped that falcons released at these sites, or their progeny, would eventually take up residence at historic cliff eyries. To date, a crossover to the Appalachian cliffs has not occurred. Some speculate this is due to the presence of great horned owls or a changing eastern landscape in which many of the falcon's traditional nesting cliffs have become overgrown with trees. Other scientists believe that it is a result of reintroduced falcons imprinting on their release sites.

Peregrines and other raptors imprint on their natal areas and tend to seek out similar places to breed when they are adults. And, in fact, current cliff eyries occur almost exclusively in areas where mountain releases took place, such as the Adirondacks in New York, Acadia National Park in Maine, the White Mountains of New Hampshire, and the Green Mountains of Vermont. But with the exception of about a dozen eyries in the Great Smoky and Blue Ridge Mountains of Tennessee and North Carolina, the falcon's old haunts in the central and southern Appalachians remain vacant. Despite federal de-listing in 1999, the peregrine is included on the state endangered or threatened lists in these regions.

As part of the original recovery effort, the CCB, the North Carolina Wildlife Resources Commission, and the Tennessee Wildlife Resources Agency released peregrines in the southern Appalachians under the supervision of The Peregrine Fund. Since many potential release sites were unsuitable due to great horned owl presence or human disturbance, they released falcons from towers placed in high elevations in the vicinity of available nest sites rather than directly on cliffs.

The Peregrine Fund discontinued its involvement in the eastern recovery effort in 1992, and the reintroduction program in the southern Appalachians ended one year later when funds ran out. Despite its premature end, the project was not without success. In the mid-1990s, falcons returned to breed in Shenandoah National Park following an absence of more than 30 years. Several pairs were also established in the mountains of West Virginia. However, these peregrines eventually disappeared, and the central and southern Appalachians remain well below the initial goal of 20 to 25 pairs for each of the five recovery regions.

Two chicks crouch under a small overhang in the first active eyrie in West Virginia's Monongahela National Forest since the 1940s.

SHAWN PADGETT / CENTER FOR CONSERVATION BIOLOGY

It was then in 1996 that Padgett conceived the idea for the project that led me to be standing on the cliffs of Maryland Heights on that unseasonably cold and wet June morning. Thanks to banding and satellite-tracking efforts, scientists are beginning to learn about the habits and ecology of this growing eastern falcon population. By using satellite telemetry to track the falcons' movements, Padgett and the CCB hope to learn how many of their birds survive to adulthood, if and where they migrate, and what breeding locations they select. In addition, questions remain as to whether or not falcons will eventually return to vacant cliffs on their own and if great horned owls will be a deterrent. "I think over time we'll see that falcons bred in the coastal

AN EASTERN *ANATUM* "DUCK HAWK" FEEDS ITS CHICKS IN A NEW HAMPSHIRE EYRIE IN THE EARLY 1930S.

CHARLES A. PROCTOR / COURTESY OF THE AUDUBON SOCIETY OF NH

RAPTOR CONSERVATION AT THE NATIONAL ZOO

BY MATT OLEAR

Perhaps the most daunting obstacle faced by Tom Cade and The Peregrine Fund when they first took up the cause of saving the peregrine falcon was the development of techniques to breed falcons in captivity. The difficulty of the task is illustrated by the fact that research into the captive breeding of raptors is still being conducted some 30 years later. By the late 1960s and early 1970s, no one had been able to breed raptors in captivity, and most people thought it was impossible—in large part because many raptors, and the peregrine falcon in particular, conduct elaborate courtship rituals that are not easily replicated in a captive setting. The Peregrine Fund was the first to breed raptors in captivity on a large scale, and the organization's overwhelming success with peregrines and other birds of prey has set the standard for scientists the world over.

One tool The Peregrine Fund used to successfully breed falcons in captivity was artificial insemination. By inseminating female peregrines with sperm taken from males raised specially as breeders, scientists were able to significantly increase the productivity of their captive stock. About half of The Peregrine Fund's falcons bred naturally; the others were artificially inseminated. Scientists were able to induce male peregrines to provide sperm through a fascinating process.

Scientists hand-raised males as selected breeders so they would imprint on people rather than on other peregrines and thus would recognize a human as a "sexual" partner. When these falcons reached breeding age, a scientist would imitate some aspects of the birds' intricate courtship rituals. In peregrines, this includes the passing and sharing of food between partners and ledge displays in which the falcons bow their heads and make soft "ee-chup" sounds. After performing these rituals, the scientist then donned a special hat with rubber tubing around the crown and turned his or her back to the male, as a female peregrine does to initiate copulation. With much noise and flapping of wings, the male follows his instinct and copulates with the hat, which collects the semen in the rubber dam.

Scientists around the world, including the National Zoo's David Wildt, Steven Monfort, and post-doctoral fellow Juan Manuel Blanco, are now conducting research to develop methods of preserving raptor semen through freezing, a process known as cryopreservation. By banking frozen raptor semen, scientists hope to save and use valuable genes from rare and dwindling populations of raptor species. Individuals of these species often fail to reproduce in captivity for unknown reasons. Artificial insemination can be used to overcome behavioral problems associated with poor breeding.

In September 2001, Wildt presented some of his team's results on raptor hormones and sperm cryopreservation at the 4th Eurasian Congress on Raptors in Seville, Spain. Among other things, Wildt and his colleagues at the Centro de Estudios de Rapaces Ibericas, near Toledo, Spain, are studying how the sperm of several threatened raptor species are affected by freezing and thawing at various rates and temperatures. They have focused on the Bonelli's eagle (*Hieraaetus fasciatus*), booted eagle (*Hieraaetus pennatus*), golden eagle (*Aquila chrysaetos*), Spanish imperial eagle (*Aquila adalberti*), and peregrine falcon. Their research has shown a marked variability in the temperatures and cooling rates the sperm of each species can withstand without suffering damage and reduced fertility. These basic data, along with new information on hormone patterns (measured noninvasively from feces), are already improving the success rate of artificial insemination. Just this past year, Blanco produced his first golden eagle chick through artificial insemination.

According to Wildt, the team has only scratched the surface of what needs to be learned about the reproductive biology of the world's declining raptors. The group plans to continue studying the relationship between hormone levels and behavior to identify the best times to inseminate birds. Also of interest is the affect of stress on birds brought to the center. Injured birds that cannot be rehabilitated and released are recruited into the captive-breeding population, but the majority of these fail to reproduce. The group hopes that by measuring stress hormones in feces they can identify ways to enrich the captive environment and improve reproduction while increasing animal well-being overall.

THE CLIFFS OF MARYLAND HEIGHTS, ACROSS THE POTOMAC RIVER FROM HARPERS FERRY. THE APPALACHIAN FALCONS THAT LAST BRED HERE IN 1952 NESTED ON A LEDGE NEAR THE FADED WHITE SIGN PAINTED ON THE CLIFF.

ERIC LONG / SMITHSONIAN INSTITUTION

CHRIS MARTIN / AUDUBON SOCIETY OF NEW HAMPSHIRE

ADULT FEMALE PEREGRINE AT ITS CLIFF EYRIE IN NEW HAMPSHIRE.

plain may start to venture toward historical mountain ranges on their own," says Craig Koppie, an endangered species biologist with the U.S. Fish & Wildlife Service. Although Cade is less convinced of this, he believes that the current cliff-nesting population will eventually expand into some of these areas. Cade also acknowledges that peregrines have returned to nest successfully on cliffs where owls had once ravaged reintroduced falcons. Two pairs of peregrines now nest on the Shawangunk ridge of the Catskill Mountains in New York, where owls had thwarted releases in the 1970s. And this spring, for the first time in more than 50 years, peregrines returned to nest on a cliff in Massachusetts, without human intervention.

These questions, however, can only be answered over time, and the ultimate goal of this project is to see what Cade and his colleagues had hoped for in the beginning: the peregrine once again occupying its rightful place in the rugged mountains and towering cliffs of the Appalachians. Padgett thinks Harpers Ferry is a good start. "My hunch," he says, "is that if we continue to hack [release falcons] in Harpers Ferry we will have falcons there in a couple of years. It is prime falcon habitat with the cliffs and the river. It's a beautiful area." His hunch is bolstered by the fact that others have had success with similar projects. A reintroduction program conducted recently along the upper Mississippi River succeeded in bringing peregrines back to cliffs in Minnesota, Wisconsin, and Iowa.

Initially begun as a two-year project, Padgett and Koppie say that they will continue to release falcons until peregrines return to Harpers Ferry and Shenandoah. The two parks are more than willing to do what it takes to see the falcons come back. According to Bill Hebb, Harpers Ferry Natural Resources Manager, the park is thrilled at the prospect of having falcons return to nest and will close a popular scenic-overlook trail during the breeding season if peregrines take up residence on the cliffs. Currently, Maryland has 12 to 14 pairs of peregrines and Virginia has 17, all of which nest on buildings, bridges, or coastal towers. Scientists believe it is likely that there are a few active eyries in remote areas of the mountains that have not yet been found, but there have been no reports of peregrines on cliffs in these states, or in Pennsylvania and West Virginia. This project hopes to change that.

When you ask someone involved in the efforts to restore the falcon why the peregrine has inspired so many people to come to its aid, not only in modern times but also throughout its long association with man as a favored bird in falconry, the common answer addresses the obvious aesthetics: the peregrine's beauty, its speed and grace, its prowess as a hunter, its mastery of its element. But the one answer that stands out is the bird's mystique—the idea that it is a unique and extraordinary bird. It is because of this quality that the epic story of the peregrine is not over. As long as it continues to inspire, there will be people who see to it that the birds endure. Z

—Matt Olear, an avid follower of peregrine falcon progress, is a media specialist and writer for FONZ.

WEB PAGES ON PEREGRINE FALCONS AND THE FALCONS' PROGRESS

College of William & Mary Center for Conservation Biology
www.ccb-wm.org

Harpers Ferry National Historical Park
www.nps.gov/hafe/falcons/

The Peregrine Fund
www.peregrinefund.org

The Raptor Resource Project
www.raptorresource.org

Brian Wheeler's raptor photographs and art
www.avianartisan.com

BY ALEX HAWES

Arizona is burning. From downtown Tucson, I spot plumes of smoke drifting south from the fires atop nearby Mount Lemmon. A flyer advertises a fabulous deal on a car splotched with red slurry from a helicopter battling the blaze. Wildfires have erupted in the Huachuca Mountains and along the Mexican border near Nogales. To the north, flames lick the ponderosa pines outside Prescott. The White Mountains, one hears, are now black.

THE FIRE

The worst of the lot—the awkwardly named Rodeo-Chediski Fire—has torched 469,000 acres of eastern Arizona pine forest, easily establishing itself as the largest fire in the state's history. First igniting on the Fort Apache Indian Reservation, the Rodeo Fire has spread north through drought-stricken pinyon-juniper and ponderosa pine forests, eventually merging with the smaller Chediski blaze, which was set by a lost hiker.

KAREN WATTENMAKER / NIFC

THE VALLEY COMPLEX FIRE, DARBY, MONTANA, 2000.

KAREN WATTENMAKER / NIFC

Sula Complex Fire, Sula, Montana, 2000.

In the eve of a firework-free Fourth of July, I meet up with Ken Frederick, a U.S. Forest Service officer, to trace the smoldering footsteps of the Rodeo inferno. We enter the charred land clad in yellow and green Nomex, a Space-Age material said to resist direct flame for up to six seconds. Small consolation. More important are our plastic helmets. Dead trees ("snags") and dead branches—morbidly nicknamed widow-makers—can topple at a moment's notice. While collapsing trees pose a real danger for foresters, standing snags provide prime real estate for band-tailed pigeons (*Columba fasciata*), acorn woodpeckers (*Melanerpes formicivorus*), and countless other species that descend upon a burned forest as soon as the flames recede. "It's a big salad bar to them," says Frederick.

© ALEX HAWES

KEN FREDERICK OF THE U.S. FOREST SERVICE SURVEYS THE FOREST AT THE RODEO FIRE IN JULY OF 2002.

Nature is nurtured by flame. Fire clears away clogged vegetation, stimulates the growth of new forbs, and creates a mosaic of habitat that can benefit a spectrum of species. "Next spring this will look great," Frederick declares, sweeping his arm across an area where only the floor of the forest was singed. "Just watch," he says.

Ecologists celebrate the cleansing ritual that natural fires can perform upon landscapes. They also recognize, however, that certain recent conflagrations have leapt outside the normal bounds of wildland fire behavior. The Rodeo-Chediski Fire has destroyed more than 250 homes, cost $42 million to fight, yielded $102 million in insurance claims, and put the lives of more than 4,000 firefighters and other personnel in danger. In addition, the blaze burned gaping holes into the ponderosa-pine canopy—an uncharacteristic result of wildfire in this habitat.

The suppression of wildland fire beginning a century ago has upset the order fire imposes on many ecosystems. An ensuing revolution in U.S. fire policy since the 1960s has yielded an uneven effort to restore this Promethean force and the habitat it shapes. As Ken Frederick and I descend a twisting dirt road into a rocky ravine, the mottled landscape gives way to a ghastly revelation of black. This slice of forest burned hot—the fire must have gotten up into the canopy and scorched the pines from the top down. Fallen trunks still crackle with puckish flames. Charred stumps spew forth smoke like untended stoves. I find a dead lizard in the soil—not burned, just expired. The scene conjures visions of Dante's Seventh Circle of Hell.

Life may not return here for quite some time. Fire here has gone awry.

"I have often remarked with how much more comfort and pleasure I could walk in woods through which a fire had run the previous year. It will clean the forest floor like a broom perfectly smooth and clear—no twigs left to crackle underfoot, the dead and rotten wood removed—and thus in the course of two or three years new huckleberry fields are created for the town—for birds and men."

—Henry David Thoreau, June 21, 1850

About one percent of the Earth's surface burns each year. The vast majority of the North American continent experiences the touch of flame, although the average interval between fires can range from one year to 1,000 depending upon the ecosystem. Before the arrival of flame-wielding hominids, wildland fires were usually sparked by a single mechanism: lightning. The western U.S. receives an average of 20,000 strikes each day, with the heaviest concentration occurring in summer. Lightning still accounts for an estimated 65 to 80 percent of wildfires out West. Stubborn campfires, cigarette butts, downed power lines, engine sparks, arsonists, pyromaniacs, and other artificial sources light the rest.

A budding fire can hide out in the forest litter for as many as ten days before trickling outward. Forest fires require three basic ingredients to spread: oxygen, heat, and fuel, which can take the form of tree branches, dead pine needles, grasses, and the like. Grass and loose detritus allow ground fires to spread efficiently but with low intensity. Most mature trees can survive these episodes, while younger trees and saplings die off, and the forest floor is cleared of brush. Widely spaced, "park-like" stands of trees persist.

FROM THE TOP: BATTLING THE TRAIL CREEK FIRE, ATLANTA, IDAHO, AUGUST, 2000.

SEQUOIA DROPPINGS: ONCE DRIED BY FIRE, CONES HIGH IN THE CANOPY RELEASE LARGE NUMBERS OF SEEDS INTO THE EMPTY UNDERSTORY, WHICH FIRE CLEARS OF COMPETING VEGETATION.

KAREN WATTENMAKER / NIFC

Take fire out of the system for a few decades, however, and shade-tolerant trees begin to mature amid a tangle of other vegetation. What you have now are the makings of a firestorm. When a flame—natural or otherwise—sparks in a dense thicket like this, shrubs, saplings, and low-lying branches act as "ladder fuels" that carry fire into the upper reaches of the forest, where it can spread among the canopy layer, becoming a crown fire. Crown fires can incinerate even the most thick-skinned giants of the forest, forging history and nightmares. The 1967 Sundance Fire in Idaho—a crown fire that razed 50,000 acres in just nine hours—generated the energy of a Hiroshima-force atomic bomb exploding every two minutes, according to fire historian Stephen Pyne of Arizona State University.

Yet even such fiery cataclysms yield amazingly few animal mortalities. State biologists conducted a one-day survey of the Rodeo-Chediski burn area shortly after the blaze was contained. The census recorded three dead elk (*Cervus elaphus*), two dead black bears (*Ursus americanus*), but few other remains across the 200 miles the surveyors traveled. (They did spot numerous live elk, deer, songbirds, hawks, woodpeckers, lizards, and even feral horses.) Over the following month, officials found only 38 elk carcasses across nearly a half-million burned acres. Hundreds of other elk had simply scurried around—and occasionally through—the flames unharmed. The true test will come this winter, as elk and other herbivores in the White Mountains struggle to find enough forage amid the ash. The Yellowstone Fires of 1988 killed about one percent of the area's elk directly, but as much as 40 percent of the population died off during the following winter.

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Smaller animals, such as rodents and snakes, burrow underground to escape smoke and flames. Although fire can suck oxygen out of these holes and suffocate some creatures, most animals survive all but the worst conflagrations if they can tunnel several inches below the surface. The most vulnerable animals during forest fires are

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GARY ZAHM / U.S. FISH & WILDLIFE SERVICE

CLOCKWISE FROM TOP: BURGDORF JUNCTION FIRE, BURGDORF, IDAHO (JULY, 2000).

A DANGEROUS SNAG FROM A HIGH-INTENSITY BURN. A STAND-REPLACING BURN OF THIS KIND WOULD KILL ALL OF THE TREES.

A HERD OF MULE DEER.

A DESERT TORTOISE GETS THE WHITE-GLOVE TREATMENT WHILE RECEIVING A RADIO-TRANSMITTER.

ABOUT ONE PERCENT OF THE EARTH'S SURFACE BURNS EACH YEAR.

mothers who are encumbered by young, or species such as the Abert's squirrel (*Sciurus aberti*), whose instinct in the face of danger is to retreat to the treetops and remain still.

Following a fire, animal life rearranges and reestablishes itself. After the 1988 Yellowstone Fires, coyotes (*Canis latrans*), grizzly bears (*Ursus arctos*), bald eagles (*Haliaeetus leucocephalus*), and other carnivores quickly scavenged whatever carcasses remained. Northern three-toed woodpeckers (*Picoides tridactylus*) hunted for bark beetles in the snags, creating holes later inhabited by mountain bluebirds (*Sialia currucoides*) and other secondary cavity nesters. Fire forced open lodgepole pine cones, dispersing seeds for Clark's nutcrackers (*Nucifraga columbiana*) and pine siskins (*Carduelis pinus*). Beavers (*Castor canadensis*) feasted on new aspen growth.

Burning also increases the crude protein content and palatability of grasses and forbs during the first year after a fire, improving forage for elk, bison (*Bison bison*), and mule deer (*Odocoileus hemionus*). The only vertebrate species known to have suffered a long-lasting decline as a result of the Yellowstone Fires is moose (*Alces alces*), which has struggled to find sufficient willow and subalpine fir for winter forage.

Plants, being mostly immobile, rely on a bit more evolutionary creativity to outlast a raging blaze. The thick bark of the mature ponderosa pine and Douglas fir protects the cambium—the fragile layer between the bark and wood that transports water and vital nutrients—from the heat of moderate-intensity fires. Certain fire-hardy plants, especially in chaparral habitat, bear highly flammable chemicals that actually encourage the spread of fire—and the destruction of less fire-resistant plant competitors. Trees such as giant sequoias and lodgepole pines develop serotinous cones, sealed shut by resin, that open up and release seeds only when intensely heated by flame. Wildfire conveniently clears away open space where these seeds can germinate in direct sunlight and nutrient-rich ash. Gambel oaks quickly regenerate after fire via underground stems, or rhizomes—as does fireweed, whose mauve flowers are often the first to brighten a burn site. Aspen's frail, paper-like bark is little match for fire, but the tree readily re-sprouts from shallow, lateral roots. Various forb species soon burst forth from long-dormant seeds.

Fire provides a coming-out party, complete with charcoal. The corollary principle is that, in the absence of fire, these plant species—and their animal dependents—may eventually become absent themselves.

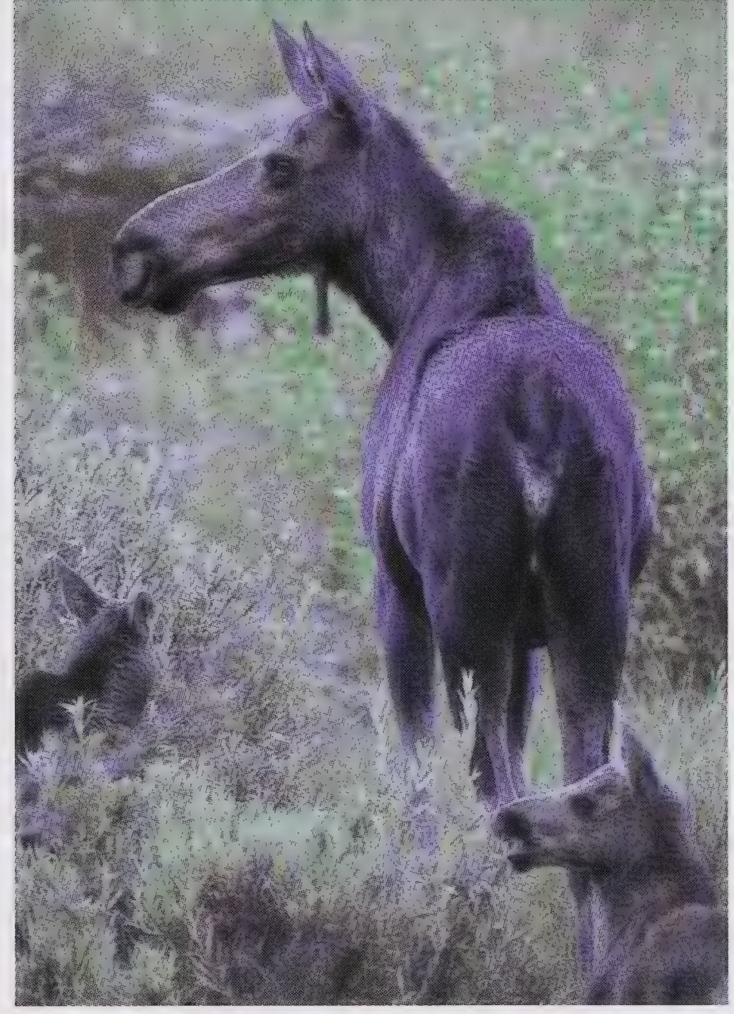
KAREN WATTENMAKER / NIFC

THE 2000 CLEAR CREEK FIRE BURNS IN SALMON, IDAHO.

"We are the fire that burns the country."

—Bantu proverb

The control of fire, anthropologists surmise, likely hastened human evolution and dispersal. In North America, indigenous tribes revered this life-force as "our Grandfather Fire." Native Americans ignited flames to flush bears from dens; to thin out forests in order to better spot deer; to drive away mosquitoes and bees; to stimulate grassland growth; to communicate with friends; to encircle enemies. So crucial was fire that the Narragansett Indians assumed the English had come to America in search of firewood.



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A FEMALE MOOSE AND CALVES GRAZE WILLOWY WETLANDS IN GRAND TETON NATIONAL PARK, WYOMING.

Thanks in part to Native Americans using fire to turn forests into grassland, bison were able to expand their range as far east as Massachusetts by the 17th century. Following the forced removal of Native Americans from much of the continent by European colonists and, later, by the U.S. government, prairie gave way again to pine forests in the South, to pinyon and juniper forests in the Southwest, and to sagebrush in the Great Basin. "The transformation of grasslands, prairies, and savannahs to forests is one of the most fundamental and widespread outcomes of European colonization," writes Stephen Pyne in *Fire in America.*

Native Americans passed on many of their forest-burning techniques to white farmers. It was the defense of timber, not farmland, that eventually beckoned the United States to declare war on fire. Appointed in 1898, Gifford Pinchot, the nation's first Chief Forester, advocated "wise use" of federal forests to preserve natural resources. His conservationist philosophy advocated not only limiting uncontrolled logging but also quashing wildland fire in all forms.

The U.S. Forest Service (USFS) faced its first real trial on August 20 and 21, 1910, when hurricane-force winds in northern Idaho and western Montana united hundreds of smaller fires into a maelstrom beyond even Dante's imaginings. The Great Idaho Fire of 1910, or simply "the Big Burn," ravaged three million acres in the Northern Rockies, killed at least 85 people, and erased entire towns from the map. Rather than draw ire to the agency, however, the Big Burn provided the USFS with both purpose and

A BISON HERD ON THE RUN IN GRAND TETON NATIONAL PARK, WYOMING.

prominence. Pinchot's successor, Henry Graves, soon declared firefighting "the fundamental obligation of the Forest Service [which] takes precedence over all other duties and activities."

The development of modern firefighting techniques and technology, including telephone-equipped lookout towers, fire roads cut into the wilderness, airplanes disgorging Smokejumpers, and flame-retardant slurry allowed federal foresters, with the help of the Civilian Conservation Corps, to achieve all too well their "10 A.M. Policy" of putting out wildfires by the morning following a fire's discovery. An average year in the 1930s saw more than 39 million acres of the U.S. charred by flame; by the 1960s that figure had dropped to fewer than five million, according to the National Interagency Fire Center (NIFC). Still, the fires came. The costs were building, and so too were the fuels.

In the hot corners of the country, a few scientists and foresters surreptitiously continued to play with fire. Beginning in 1909, Yale University forestry biologist H.H. Chapman—the first true champion of controlled burning—performed research demonstrating that southern pines rely on fire to suppress hardwood competitors, reduce hazardous fuel buildup, and stave off brown-spot disease. In 1931, Herbert L. Stoddard of the Tall Timbers Research Station in Tallahassee, Florida, published an article arguing that fire in the long-leaf pine ecosystem was particularly vital for the northern bobwhite (*Colinus virginianus*). (Today, prescribed fire is being used to restore Sonoran grasslands for the masked bobwhite, *Colinus virginianus ridgwayi*, the northern bobwhite's endangered cousin.) Another vocal advocate of fire's importance, Harold Biswell of the University of California at Berkeley, almost got kicked out of the School of Forestry in 1950 for his pyromantic musings. Biswell later proved that sequoias depend on fire to kill the seeds of neighboring trees.

The naturalist Aldo Leopold—who died, ironically, while helping neighbors battle a grass fire in 1948—wondered whether fighting wildfire was even worth the government's effort. But it was Aldo's son who had a far greater role in rekindling the flames. A. Starker Leopold headed a federally appointed committee charged with re-examining management procedures in the national parks. The Leopold Report, released in March 1963, declared, "A national park should represent a vignette of primitive America." One key tool the committee recommended for restoring this pre-Columbian vision was prescribed burning. The government's attitude toward fire had suddenly shifted east to west.

"Behold, how great a matter a little fire kindleth!"

—Epistle of James, Chapter III, verse five

The frequency and intensity of wildland fire—known as a fire regime—varies dramatically from habitat to habitat. Historically, fires on a given patch of Missouri prairie raged every year, those in alpine tundra or in New England balsam forest every millennium on average. Through a prism of flame, the workings of elaborate ecosystems can be discerned, and perhaps rejuvenated.

Fire is no stranger to the land charred by the Rodeo blaze, being home to the largest stand of ponderosa pine on the planet. Ponderosa pine relies on fire to remove shade-tolerant Douglas-fir and spruce competitors. The pine's thick, puzzle-piece bark insulates its cambium, while its lower limbs drop off during its growth to prevent flames from climbing into the canopy. Grasses interspersed between mature pines normally transport low-intensity fires ignited by the Southwest's frequent lightning storms. These modest burns yield a mosaic of thin, open

SCOTT FRIER/NIKON, U.S. FISH & WILDLIFE SERVICE

THE CALIFORNIA CONDOR STRUGGLES TO FIND CARRION IN OVERGROWN LANDSCAPES.

forest—offering good perches and sightlines for raptors like the sharp-shinned hawk (*Accipiter striatus*), the northern goshawk (*Accipiter gentilis*), and the threatened Mexican spotted owl (*Strix occidentalis lucida*).

However, livestock ranching over the past century has removed much of the grass cover, encouraging the build-up of woody growth, and yielding either no fire—or crown fire. "Blaming it all on fire suppression would be a mistake," says Stephen Pyne. "In the Southwest, it begins with grazing."

A similar story is told on the opposite coast. Once covering several million acres of sandy coastal plains in the Southeast, longleaf pine forests have been reduced to two percent of their former reign. The removal of fire is partly to blame. As elsewhere, southern pines can resist fire better than their hardwood competitors. Historically, the forest is bathed in flame every two to five years on average. Many birds that evolved in this particular fire regime vanish after only five years of fire suppression.

The endangered red-cockaded woodpecker (*Picoides borealis*) inhabits longleaf as well as loblolly and shortleaf pine forests. Understory fires are essential to prevent the development of hardwood mid-story growth; without such fires, these birds will abandon their territory. Red-cockaded woodpeckers today are found predominantly in areas with a history of aggressive, prescribed burning. In addition, understory burning increases populations of arthropods—many of which breed and feed in charred trees—likely aiding insectivorous loggerhead shrikes (*Lanius ludovicianus*) and American kestrels (*Falco sparverius*). Threatened gopher tortoises (*Gopherus polyphemus*) also benefit from the open ground-cover afforded by burning in longleaf pines.

The salve of flame extends beyond the forests. Wildfires allow grasslands to beat back the invasion of trees and shrubs. Prairie blazes burn the tops of grassy plants, leaving healthy roots to regenerate amid the fertilizing ash. Fire exclusion, however, has encouraged the encroachment of woody vegetation, fragmenting tallgrass prairie habitat for a host of species, most notably the greater prairie-chicken (*Tympanuchus cupido*) and Henslow's sparrow (*Ammodramus henslowii*).

The chaparral (scrub oak) habitat of southern California ranks among the most explosive fire regimes on the planet. Wildfires tear through this habitat every 20 to 25 years, fueled by oils and resins in many local plants, and by the hot, dry Santa Ana winds. These conflagrations suit the wild inhabitants just fine. Laurel sumac, big berry manzanita, lemonade bush, and other typical chaparral plants require fire to germinate. Without fire, deer and ground-dwelling birds have trouble foraging amid the dense scrub. The endangered California condor (*Gymnogyps californianus*) nearly went extinct; this was due, in part, to the havoc wrought by wildland fire's absence. As the chaparral vegetation grew ever thicker, condors had trouble spotting rabbits and other small mammal prey, which themselves thrive in a landscape periodically renewed in flame. But with real estate properties pushing ever farther into California's sun-baked scrubland, the pressure to suppress fire here continues.

"A stand-replacing fire is nature's reset button," says Ken Frederick. "It takes the forest back to an early successional stage, to start over." But public tolerance for inferno can stretch only so far.

"...flame is not a kind of ecological pixie dust that, sprinkled over the land, will transform the bad and ugly into the good and beautiful. Messed-up forests only yield messed-up fires."

—*Stephen Pyne,* "The Big Blowup"

In the spring of 2000, the Cerro Grande Fire torched 48,000 acres of northern New Mexico's Jemez Mountains, forcing the

SMOKEY COMES TO WASHINGTON

Under the threat that the Japanese might set fire to western forests with incendiary balloons, the U.S. government during World War II responded with a uniquely American weapon: marketing. The War Advertising Council mobilized professional talent behind a campaign of forest fire prevention. The 1942 movie *Bambi* had seared a vision of wildfire into the minds of a nation of children, but licensing issues with Disney prevented the cartoon fawn's image from being used. Instead, artist Albert Staehle was commissioned on August 9, 1944, to create an original spokes-animal, Smokey Bear, named after "Smokey" Joe Martin, Assistant Chief of the New York City Fire Department from 1919 to 1930.

The first Smokey poster appeared in 1945. Soon after, Washington, D.C., disc jockey Jackson Weaver created Smokey's radio voice by droning into an empty trashcan, "Remember, ONLY YOU can prevent forest fires."

But there was no substitute for the real thing. When a young American black bear (*Ursus americanus*) was orphaned by a wildfire in New Mexico's Lincoln National Forest in 1950, the U.S. Forest Service knew they had their cub. The bear was transferred to the Smithsonian's National Zoo as an ambassador of forest fire prevention. As a symbolic figure, Smokey was second in popularity only to Santa Claus. In April 1964, the Zoo's Smokey Bear earned his own zip code, 20252, because of all the mail he was receiving.

Smokey was joined at the Zoo by a mate, Goldie—another New Mexico orphan—in 1962, but the two never bore any offspring. He died November 9, 1976, just as the Jolly Green Giant and Big Bird were usurping the throne of public recognition, and as the philosophy of fire exclusion was yielding to one aimed at restoring natural fire regimes.

Nonetheless, the appeal of Smokey has ignited worldwide. Smokey dons a sombrero in Mexico as Simón El Oro and has transformed into a rabbit in Spain, a moose in Russia, a deer in Turkey, and—strangest of all—a ladybug married to a computer in Italy.

—*Alex Hawes*

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evacuation of 18,000 people, destroying more than 235 homes, and causing more than $1 billion in damage. The fire was not only lit by human hands—but by federal foresters performing a prescribed burn in Bandelier National Monument. High winds and dry fuels following a La Niña winter thrust the flames outside their established boundaries and sent scientists at Los Alamos National Laboratory scurrying for cover.

A pristine ponderosa pine forest, in theory, should hold 40 to 150 pines per acre. In some areas of the Jemez Mountains today, more than 2,000 ponderosa pines are squeezed into an acre of canopy, a result of decades of fire suppression. Controlled burns can either reduce these fuels—or cause the fuels to explode.

"We've pretty well run over the woods," argues Stephen Pyne. "The land has changed so much that putting fire back into it would be like dumping wolves into a shopping mall." Pyne argues that forest thinning—the mechanized removal of trees done either by the U.S. Forest Service or contract loggers—is necessary in areas where the build-up of fuels precludes controlled burning. But many environmentalists are suspicious that thinning projects give commercial loggers an excuse to strip the forest of its most precious assets under the guise of forest restoration.

THE NATURALIST ALDO LEOPOLD—WHO DIED, IRONICALLY, WHILE HELPING NEIGHBORS BATTLE A GRASS FIRE IN 1948—WONDERED WHETHER FIGHTING WILDFIRE WAS EVEN WORTH THE GOVERNMENT'S EFFORT.

"Old-growth ponderosa pine forest is in short supply," says Craig Gehrke of the Wilderness Society. "If it comes down to losing the big trees to save the forest, I'm not sure that's an equitable trade." The most sought-after component of the forest—the lofty, centuries-old trees—are also the least flammable and the most important ecologically. Removing mature, old-growth trees during thinning operations makes little or no sense from a fire-prevention perspective. From an economic perspective, however, timber companies arguably can't make a profit without harvesting at least some larger-diameter trees, and the Forest Service lacks the budget to perform thinning operations on its own.

The Bush Administration recently announced its intentions to ease regulations on logging in national forests in order to reduce fuels. Currently, the USFS is planning a thinning project outside Flagstaff that would allow contractors to extract 6,000 large-diameter ponderosa-pines to help offset the costs of thinning a modest 10,400 acres of forest. However, an estimated 1.2 million acres of overgrown ponderosa-pine timberland surround Flagstaff. Something must give before the next conflagration ignites.

"To the best of our knowledge, the burning of these high-intensity fire patches are off the scale. They're historically anomalous," says Thomas Swetnam, director of the Laboratory of Tree-Ring Research at the University of Arizona. Swetnam has studied centuries of tree-ring data from the Southwest to unlock pre-colonial fire regimes in ponderosa-pine forests and other habitats. Fires occurred with great regularity here thanks to the ubiquity of lightning, but Swetnam can find nothing to suggest Rodeo-style blazes torching the landscape before the double-whammy introduction of livestock grazing and fire suppression. "You don't see evidence of those kinds of 1,000- to 10,000-acre holes in the canopy burning at these elevation before the 1950s," he says.

Far less well understood is how these monster fires—the offspring of 20th-century forestry and grazing activities—are affecting wildlife. Species with highly restricted ranges are inherently vulnerable to catastrophic blazes. In 1916, the world's remnant population of 2,000 heath hens (*Tympanuchus cupido cupido*) was confined to the island of Martha's Vineyard when a scrub fire sent them on the road to extinction. The 1990

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KAREN WATTENMAKER / NIFC

AN AREA OF BURGDORF JUNCTION, IDAHO, REGROWS, BUT PERHAPS SHOWS POOR FUEL MANAGEMENT.

Dude Fire, which struck just west of the site of the Rodeo-Chediski Fire, wiped out a small population of thick-billed parrots (*Rhynchopsitta pachyrhyncha*), temporarily ending a reintroduction project for that species in Arizona. Severe fires today might destroy critical nesting trees for threatened Mexican and California spotted owls (*Strix occidentalis occidentalis*); only time will tell how Mexican spotted owls fare in the wake of the Rodeo Fire.

Crown fires can also sterilize the soil and cause erosion of silt and ash into streams and rivers, altering their water chemistry and temperature. This influx of nutrients can either spawn algal growth and, in turn, buoy aquatic invertebrates and native fish—or overwhelm the ecosystem entirely. Arizona state biologists are monitoring the effects of the Rodeo-Chediski Fire on the threatened Little Colorado River spinedace (*Lepidomeda vittata*). The 1994 Rattlesnake Fire in the Chiricahua Mountains nearly eliminated the Mexican stoneroller (*Campostoma ornatum*) from Rucker Canyon, the small minnow's only foothold in Arizona. The Dude Fire, on the other hand, presented the Arizona Game & Fish Department with an opportunity: after erosion killed off rainbow trout (*Oncorhynchus mykiss*) and other non-native sports fish, state officials reintroduced native Gila trout (*O. gilae*). State biologists have literally tens of thousands of native Apache trout (*O. apache*) in fish hatcheries awaiting reintroduction if post-Rodeo conditions permit.

Invasive species can interact with fire in more troubling ways. Russian thistle—better known as tumbleweed—was first introduced to America from the Siberian steppes in 1873. As the plant dries, the base of the stem becomes brittle and breaks off, dispersing thousands of seeds as it topples in the wind. Wildfires can spread rapidly when tumbleweed firebrands roll through grasslands. More alarmingly, cheatgrass, another Russian import, has taken advantage of its fire-tolerance to conquer the Great Basin, bringing flames in and pushing native plants like sagebrush—which requires as much as 50 years to recover from wildfire—out. So far, the invasion of cheatgrass is known to have harmed populations of mule deer and pronghorn (*Antilocapra americana*)—which avoid eating the plant—as well as sage grouse (*Centrocercus urophasianus*), Townsend's ground squirrel (*Spermophilus townsendii*), prairie falcon (*Falco mexicanus*), golden eagle (*Aquila chrysaetos*), and several other species.

Exotic grasses are also summoning fire into the Sonoran Desert, an ecosystem that U.S. Geological Survey (USGS) ecologist Cecil Schwalbe calls "essentially naïve to fire." A herpetologist by training, Schwalbe has studied the impact of Mediterranean red brome and African buffelgrass on desert tortoises (*Gopherus agassizi*), saguaro cactus, and other Sonoran species. Ranchers originally planted buffelgrass on millions of acres in northern Mexico for cattle forage. The grasses spread, and with them wildfire. A single blaze, the 1994 Mother's Day Fire in Saguaro National Park, burned 340 acres of prime desert tortoise habitat, killing 11 percent of the adult tortoise population there. (The normal mortality rate of desert tortoises, Schwalbe cautions, is only two percent a year.) The Mother's Day Fire also killed more than 20 percent of the saguaro cacti over the course of the next five years—destroying food and shelter for a host of desert species.

"Because buffelgrass resprouts vigorously after fire, it is capable of causing more frequent and larger wildfires," said Todd Esque, Schwalbe's research collaborator at USGS, during a recent Ecological Society of America conference in Tucson. "These changes could potentially convert Sonoran Desert shrublands to exotic fire-driven grasslands, completely altering the kinds of plants in the Sonoran Desert and even eliminating saguaros in some areas."

One positive outcome of the landmark 2000 fire season has been Congressional passage of the National Fire Plan, which has allocated $1.9 billion to help minimize the impact of invasive species following fires, as well as to rehabilitate burned forests, reduce hazardous fuels, and rebuild communities. The plan also aims to educate the growing number of homeowners who live in areas susceptible to wildfire.

"We need to move the discussion away from the simple orthodoxy that natural fire is good to a new debate to begin talking about where fire is necessary, where it's optional, and where it's too dangerous," says Stephen Pyne. "That doesn't seem too difficult to do."

Little by little, our society is learning to live with—if not love—fire. Amid the smoke, one thing is clear: The fires will return, and we must be ready.

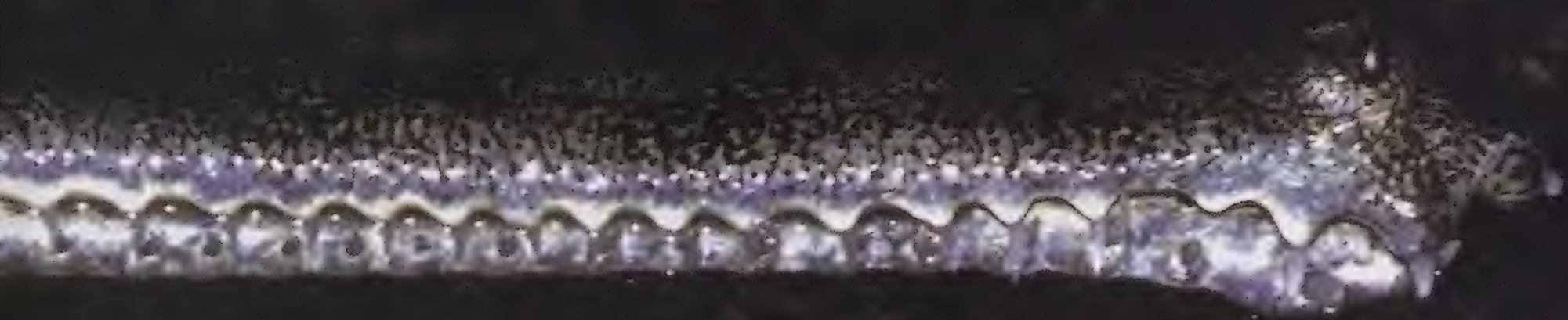
"And God gave Noah the rainbow sign.
No more water, the fire next time."

—Alex Hawes, a former Associate Editor of ZooGoer, *moved to Tucson last spring—just in time for record heat, record drought, and record fire.*

Karen Wattenmaker Photography:
www.kwphoto.com
NIFC Fire-photo archive:
www.firepix.com

GHARIALS STAR IN THE REPTILE DISCOVERY CENTER AND ON GHARIAL CAM

Imagine coming face to face with a crocodile bearing more than a hundred razor-sharp teeth in foot-and-a-half-long jaws. Sound terrifying? It certainly would be if you met a gharial while strolling along a riverbank in India or Nepal. But you can safely see these crocodiles at the Smithsonian National Zoo's Reptile Discovery Center, and now, for the first time, on our new underwater Gharial Cam at http://www.nationalzoo.si.edu/webcams/gharial.htm.



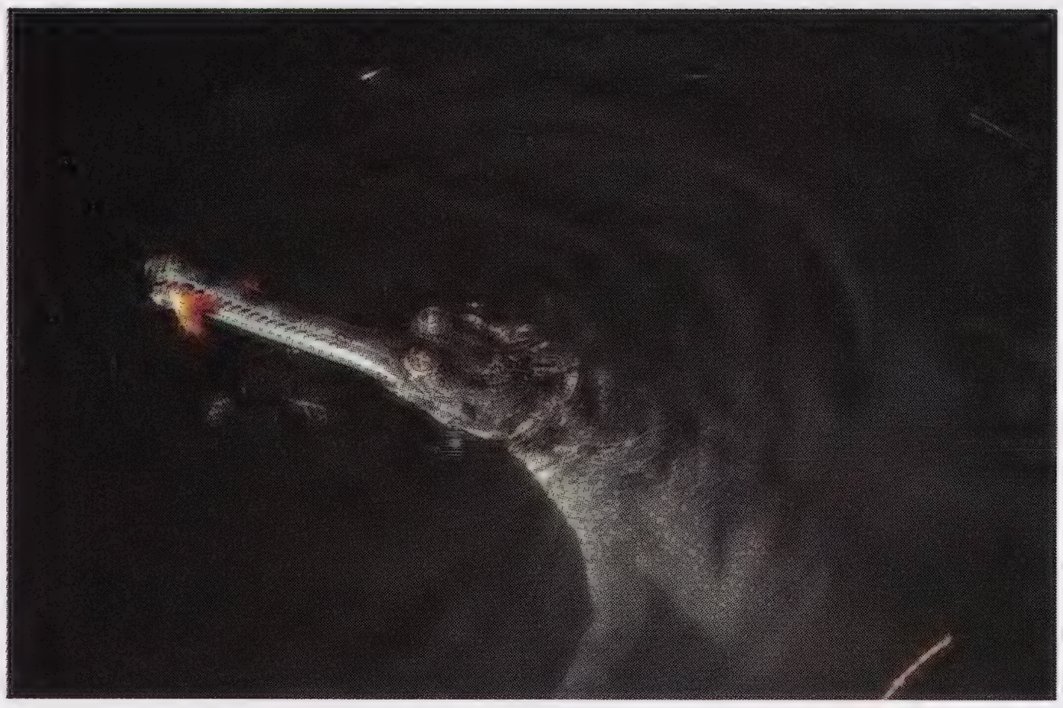
JESSIE COHEN / NZP

AT THE ZOO

Gharials, sometimes called gavial from their scientific name, *Gavialis gangeticus*, are one of the world's largest crocodiles. (See "What's in a Name" on page 30 for the story behind the name.) Adult males reach between 16 and 20 feet in length, with some reports of animals as long as 23 feet. Females are smaller, but still reach a hefty 13 feet or more. Despite their enormous size and fearsome teeth, however, gharials tend to avoid rather than attack people. Indeed, their extremely long and narrow jaws and thin teeth aren't strong enough to grab and tear apart large prey like Nile crocodiles and some others do. Gharials are almost exclusively fish eaters. The predator waits passively for schools of fish to swim alongside it, then, in a lightening-fast sideways swing, snaps its jaws to seize the luckless victim in those deadly teeth. The long, narrow snout offers little resistance in the water, while the puncturing teeth are adapted to hold slippery, struggling fish. Once the gharial has the fish under control, it raises its head out of the water and repositions the fish to be swallowed whole, head first.

If you're lucky when you tune into the web cam, you might glimpse a Zoo gharial catch one of the tilapia that share their pond. These fast-moving, agile fish pose a real challenge to the gharials' predatory skills, however, as they typically catch slower fish in the wild. Thus, the occasional live tilapia meal forms a small part of their Zoo diet. Keepers hand-feed them chunks of tilapia meat as their main sustenance.

Scientists label gharials as the strangest of all crocodilians. Twenty-three living species of crocodilians form the order of reptiles technically called the Crocodylia. The Crocodylia, in turn, is composed of three families. The family Alligatoridae includes seven species: the familiar American alligator, its close relative the Chinese alligator, and five species of caiman, all native to South America. The family Crocodilidae contains 12 species of "true" crocodiles, such as the American crocodile, Nile crocodile, and muggar crocodile. It also includes one unusual species, known as the false gharial because it too is a fish-eater with a long, slender snout.



JESSIE COHEN / NZP

ONE OF THE ZOO'S GHARIALS AT FEEDING TIME. THE FARE IS LIVE GOLDFISH.

JESSIE COHEN / NZP

WILD GHARIALS CONGREGATE NEAR THE RIVER'S SHORE, INDIA.

Finally, in a family all its own—the Gavialidae—is the single species we call the gharial. It is the most aquatic member of the order and leaves the water only to bask and nest, usually on sandbanks. On land, the animal's weak legs restrict it to pushing itself forward on its belly. Other crocodiles move on land like most mammals do, in what is called a "high walk." Adult male gharial also sport an unusual knob, called a *ghara*, that bulges from the tip of its snout.

This species was not always so lonely. Long-snouted gavial ancestors first appeared in North Africa more than 25 million years ago, then are believed to have spread to India, Europe, and the Americas, diversified into various species, then became extinct everywhere except Asia. Species of Gavialis first appear in the Asian fossil record in the Miocene, which began 20 to 23 million years ago; however, all but one were gone by about two million years ago. And gharials today have a distribution restricted to the northern part of the Indian subcontinent. Most live in India and Nepal, and a few are believed to remain in Pakistan, Bhutan, Bangladesh, and possibly in Myanmar (Burma). This last surviving Gavialis is in danger of extinction.

Only an estimated 2,500 to 3,000 individuals remain today—but that's actually the good news! In 1975, conservationists believed that fewer than 100 gharials remained. The reasons for the gharial's decline are depressingly familiar. They were hunted for sport and for skins; their eggs were collected for food and traditional medicine. Their habitat—calm parts of fast-flowing deep rivers with sandbanks for nesting—has been reduced as a result of rivers being dammed for power and irrigation. Riverbanks have been converted to farms and other human settlements. Rivers have been polluted by farm runoff and mine tailings. Gharials get caught up in fishing nets and drown or are killed by fishermen. Fishermen don't like gharials—a net torn up by a captured gharial represents a substantial economic loss. They also believe that gharials compete with them for food. It turns out, though, that gharials eat many fish that prey upon fish species sought by fishermen. With fewer gharials eating the predators, these preferred food fish are declining.

Aggressive conservation action in India and Nepal is responsible for the gharial's partial recovery, although its status is still precarious. Conservation breeding and restocking programs have been in place since 1975 in India and 1978 in Nepal. In fact, the Smithsonian Institution helped to establish Nepal's Gharial Crocodile Reproductive Centre in the Royal Chitwan National Park.

These programs used both wild and captive gharials to help increase their numbers. A large percentage of the 35 to 60 eggs a female lays in the wild won't survive to adulthood. To improve the odds, some wild eggs are also collected, artificially incubated, raised to juvenile age, and then released. Gharials are also bred in captivity so their young can be released into the wild. The process is relatively slow. Females don't reach breeding age until they reach eight to nine feet long when they are eight or more years old; males aren't sexually mature until they reach 13 feet long at 15 to 18 or more years of age. Recovery seems to have leveled off, however, because the available habitat is full and some small populations are not growing and must be replenished from the captive stock.

Two gharials have been residents of the National Zoo since 1982. They hatched in 1979 from eggs taken from the wild and incubated and raised at the Nepal breeding center, and came to the Zoo as a gift from the then-king of Nepal. Both are now about ten feet long and one is developing its ghara, the knob-like protuberance on the end of its snout. According to Michael Davenport, Zoo assistant curator and herpetologist, this confirmed for him that this individual is a male—the sexes are very difficult to tell apart by other visual cues. The ghara eventually forms a lid on the nostrils. When a male exhales, the lid flaps, creating a buzzing sound. The sound appears to function in courtship and territorial defense. Davenport believes the second gharial is a female. Gharials are seasonal breeders, and, in January of the last two years, Reptile Discovery Center staff noted some unusual interactions between the two that might have been courting behavior. However, they saw no matings and no eggs were hatched. The staff are waiting to see what happens in January 2003.

Like most reptiles, gharials aren't the liveliest of beasts. But they are still fascinating to watch, both in person and on the underwater cam. And while waiting for the gharial to move, you can follow the swarming tilapia, which often spawn in the pond. The Reptile Discovery Center's winter hours are 10:00 a.m. to 4:30 p.m. daily. You can see gharials and tilapia on the cam. Z

—*Susan Lumpkin*

Gharial Cam is just one of many new webcams the Zoo has installed in recent months. The underwater Amazon River Fishes Cam is beautiful and a few minutes of watching the fishes is a great stress reliever. Other new cams feature flamingos, octopus, and, soon, black-footed ferrets. To see the entire list, go to http://www.nationalzoo.si.edu.

Books, Naturally

American Bison: A Natural History. **Dale F. Lott. 2002. University of California Press, Berkeley. 230 pp., clothbound. $29.95.**

Dale Lott loves bison and this book is a love song.

No one has studied the behavior of these quintessential North American animals as long or as thoroughly as Lott. He actually lived the first six years of his life on the National Bison Range in Montana and then resided just a few miles away until going to college. After earning his Ph.D. studying rats, he took up the scientific study of bison in 1965 as a 30-year-old assistant professor at the University of California, Davis, and never stopped.

American Bison thus represents the culmination of more than 35 years of research and a lifetime of living alongside a North American icon with people who helped shape the fate of bison in the 20th century—for starters, both his father and his father-in-law worked at National Bison Range.

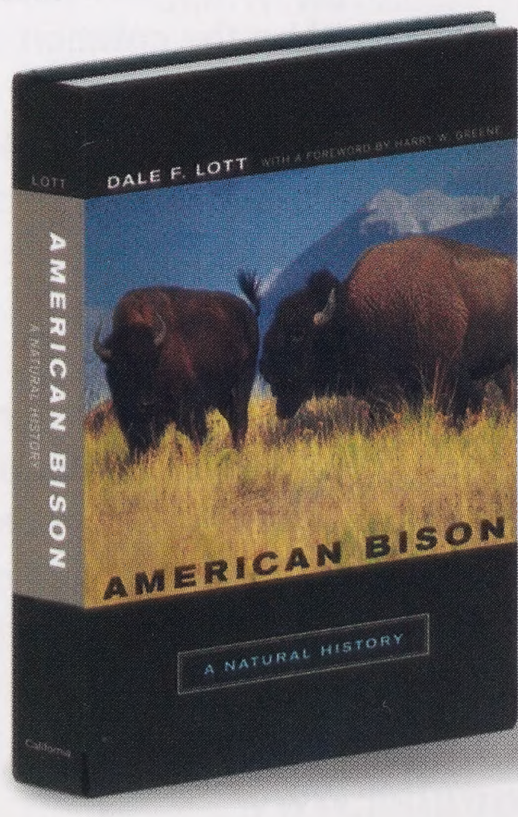
The book is divided into six parts. The first, "Relationships, Relationships," covers the social life of bison, which live in large herds where males compete for females, females compete over grass to eat, and mothers and calves have first affectionate, then antagonistic, interactions. Pretty standard stuff in behavioral ecology, but Lott imbues the material with such a deep understanding of these complex social dynamics that I felt as if the bison were telling me their own story in grunts and bellows I could comprehend.

Lott employs an opera analogy to describe his own gradually acquired knowledge. When he first began to study bison, he writes, "… I experienced bison social interactions primarily as a grand but largely incomprehensible spectacle, like an opera sung in Italian …. [Later] it became like watching an Italian opera with translated lyrics projected as supertitles above the stage …. [Now] I've tried to convey some of the drama of bison social behavior in a few scenes without projecting text above them. But the behavioral ecologist's job, and my passion, is to go beyond rhapsodic appreciation by translating the lyrics so that the story line can emerge. Bison social behavior is too marvelous a tale to go untold."

Two parts on "The Machinery of a Bison's Life" and "Whence They Came Forth, and How Much They Multiplied" have the same compelling immediacy, so that details on digestion or how grass grows, subjects so easy to make mind-numbing, become fascinating. Lott is too good a scientist to have to resort to jargon to describe scientific subjects or fear charges of anthropomorphism. He concedes that bison—*Bison bison*—is the proper name of his beast, but prefers the more evocative buffalo. Lott is plain-spoken and the prose throughout is refreshingly clear and sometimes very funny.

Plant material is digested by bacteria in a bison's rumen. The process is called fermentation, the same process that is used to produce wine and other alcoholic beverages. Writes Lott, "Like all living things, these fermentation bacteria have waste products, which include alcohol. It's a sobering fact that 12 or 13 percent of a bottle of Dom Perignon Champagne is bacteria pee." Talking about how bison must lose body heat during the heat of summer, he says, "If they couldn't get rid of the heat … they would soon be walking pot roasts."

Part five offers capsule accounts of "The Bison's Neighbors," including wolves, pronghorns, and grizzlies, as well as ticks, anthrax, and a single bird species he calls the buffalo bird. It is a testament to the bison's rarity—and the supremacy of domestic cattle—that most of us call this species the cowbird.



The final part of the book, "Human and Buffalo" tells the sad history of the bison's near demise in the years following European settlement of North America, and its modest recovery in the last century. The story is familiar but told with clarity and compassion. Lott doesn't divide the world into good guys and bad guys, just guys with different needs and different values. He makes the point several times that wildlife management is the public manifestation of private attitudes, with politics deciding whose values prevail. Expressed more bluntly, "In America today, all wild things and wilderness always hang by the slender thread of individuals giving a damn."

Lott concludes with a plea for a Great Plains Park in the United States linked to Canada's Grasslands National Park. This expansive protected area could lead to a restoration of the glories of the American plains, which once rivaled those of Africa's savannas. With people like Dale Lott giving a damn, this dream seems achievable—and the slender thread of concern feels like a thick rope on which the bison's future can be secured.

In *American Bison*, Lott reveals himself as a man I'd like to know, to sit and savor a glass of wine with and listen to his stories as the sun goes down over the Rockies. Reading his book is the next best thing. Try it, with or without the wine. You'll love it.

—*Susan Lumpkin*

GOOD NEWS

A lethal diet for mosquito larvae may be a new weapon against West Nile virus and other mosquito-borne diseases. Researchers discovered that a hormone normally produced in mosquito ovaries acts to switch off its digestive system. Larvae fed this hormone starve to death before they are old enough to fly and bite.

Intrigued when normal egg development was halted by implanting mature ovaries into female mosquitoes, researchers looked for a bug "birth control pill." After isolating the chemical involved, they found it prevents the digestion of blood, shutting down egg production.

In an adult female, this hormone signals gut cells to halt digestion of proteins when the ovaries have enough essential amino acids—the building blocks of proteins—to complete egg synthesis. When administered to larvae, it prevents them from acquiring the nutrition for normal growth and development.

The gene has now been placed into yeast—appealing larvae food—and the resulting pesticide may hit store shelves before next year's mosquito season. The product—Skeetercide—is spread on water surfaces where mosquito eggs are likely to hatch. It works in both salt and fresh water and is safe enough to use in drinking water containers. It kills a wide array of mosquito species, which could prove important with new tiger mosquitoes, West Nile virus, and malaria now in the Washington area.

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BAD NEWS

Ordinary weeds can become stronger and more successful by incorporating genes from closely related crop plants that have been genetically modified (GM) to fend off pests, according to a new study by Ohio State University researchers.

Wild sunflowers became more resistant to pests and produced 50 percent more seeds when crossbred with GM crop sunflowers containing *Bt* toxin, a crystalline protein from the *Bacillus thuringiensis* bacteria, which eats away at the gut of a variety of insects. Researchers were surprised that transference of a single gene could lead to such a jump in reproductive success.

Although these plants were crossbred by hand, previous studies have shown that 20 common crops, including sorghum, rice, and squash, often crossbreed with related weeds within six-tenths of a mile. Genetically modified pest-resistant versions of these crops are not currently on the market in the United States.

Once gene transfer has occurred, the new genes are likely to persist in the weed population indefinitely. One possible result could be the creation of much hardier and difficult-to-control weeds.

"We need to be careful and ask what the benefits and the risks are when dealing with these products," said Allison Snow, a co-author of the study. "We are already spending a lot of money trying to stop weeds, and we want to be careful not to exacerbate those problems."

MORE NEWS

In the March/April edition of *ZooGoer*, John Tidwell discussed the recognition of a second species of African elephant and mentioned the possibility of a third. Now, DNA extracted from wild-elephant dung has provided strong evidence for that third species, the western elephant.

National Zoo conservation geneticist Lori Eggert found that elephants in West Africa make up a genetically distinct population that diverged from the continent's other elephant populations about 2.4 million years. By collecting dung samples, researchers were able to retrieve DNA from cells that had been scraped off the intestinal lining. This study focused on maternally transmitted DNA, so it needs to be confirmed by further studies using DNA sequences that are inherited both paternally and maternally.

The vast majority of Africa's 400,000 to 500,000 elephants are the savanna-dwelling *Loxodonta africana*. The smaller, shyer forest elephants (*Loxodonta cyclotis*) were listed as a separate species earlier this year and number about 150,000. This new West African elephant species, which has yet to be given a scientific name, probably numbers only about 12,000, placing them in the highly endangered category. Scientists warn that conservation plans will now need to be re-worked to take into account three distinct species of African elephant.

—*Melissa Braddock, Intern*

WHAT'S IN A NAME

Common and scientific animal names often include misspelled words, especially when they are derived from languages unfamiliar to the person naming them. The scientific name for the crocodylian called "gharial" offers an example: *Gavialis gangeticus*. (See "Gharial Star in the Reptile Discovery Center and on Gharial Cam" on page 26.) *Gavialis* and gavial, an often-used common name, are corruptions of the word *ghariyal*, which is Hindi for crocodile and, in turn, is derived from the Hindi *ghara*, a type of Indian pot. The knob on the end of an adult male's snout resembles the shape of the pot. The knob is called a ghara. The word *gangeticus* means "belonging to the Ganges River," one of a handful of rivers on the Indian subcontinent where the species is found. Another species known as the "false gavial" goes by *Tomistoma schlegelii*. *Tomos* is Greek for cutting or sharp; and *stoma* is Greek for mouth. This refers to the animal's long slender snout, which, of course, is why it was once believed to be a gharial. A Dutch zoologist named Schlegel is credited with discovering this species, hence *schlegelii*. This suggests a better common name might have been Schlegel's sharp-mouth crocodile, but false gavial seems to have stuck.

—*Susan Lumpkin*

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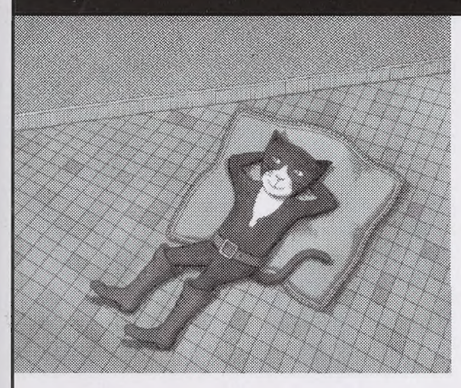
Children's Film Program



Film still from *Puss in Boots*

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